THE ENHANCEMENT OF PROBLEM FINDING AND PROBLEM SOLVING

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ABSTRACT

The study examined the problem finding behaviour of novices and those with experience within a banking organization. This was undertaken with a view to enhancing problem finding and problem solving.

45 bank Tellers, comprising equal numbers of novice, intermediate and experienced Tellers, recorded work related problems in a survey form, over the period of one working day.

Measures of the number of problems, the number of hidden problems and the number of novel problems recorded by Tellers were determined.

Novice Tellers were found to identify significantly more problems, more hidden problems and more novel problems than intermediate and experienced Tellers. Therefore, novices were found to be better problem finders than those with experience.

This result suggests that problem finding can be enhanced by novices identifying problems rather than those with experience.

Further, it is suggested that problem solving can be enhanced by those with experience solving the problems that novices identify.

INTRODUCTION

Creativity may be classified into four main areas: the creative person, the creative product, the creative press (the relationship between people and their environment) and the creative process (Isaksen,1987; Rhodes,1987).

The background to this thesis is the study of the creative process. The reason for this background is that an understanding of the creative process can lead to the development of techniques for enhancing creativity.

The creative process may be defined as being comprised of three stages: problem finding, problem solving and solution implementation (Basadur 1987; Isaksen,1987).

The author will review techniques that are designed to enhance both the problem solving and problem finding stages of the creative process.

Problem Solving

Techniques to enhance creativity have almost always involved the problem solving stage of the creative process. Possibly the most popular and widely used are brainstorming and synectics.

Brainstorming involves the generation of potential solutions to a problem without evaluation or judgement. These are then evaluated and the best solutions are selected (Osborn, 1963).

Brainstorming has been shown to be effective in enhancing problem solving (Parnes & Meadow,1959; Meadow, Parnes & Reese,1959;

Sappington & Farrar (1982) and it also seems to be more effective when used by individuals rather than within groups of people (Bouchard & Hare, 1970; Taylor, Berry & Block,1958).

Synectics, proposed by Gordon (1961), assumes that all problems encountered will initially seem unfamiliar. To enhance problem solving, synectics recommends that previous information should be used to make the unfamiliar problem seem familiar. Analogies and metaphors are then applied to the familiar problem to break down its perceived boundaries.

Gordon notes that it is only by viewing familiar problems in unfamiliar ways that creative problem solving can be achieved. For example, Gordon observed that experts with all their knowledge are seldom able to create new ideas. "The expert tends to discuss the problem in the language of his own technology. This language can surround the problem with an impenetratable jacket so that nothing can be added or modified. The result is that it becomes impossible to view the problem in a new way ... yet the knowledge of the expert is necessary for technical breakthrough" (p.95).

Synectics shares a number of similarities with brainstorming. Stein (1974b) wrote "Both synectics and brainstorming involve the generation of ideas under conditions in which criticism, evaluation, and other characteristics of critical problem-solving behavior are deferred or suspended" (p.184). A comparison of synectics and brainstorming group procedures by Bouchard (1972) found that the synectics group procedure was superior to brainstorming. However, it may be that some problems are more effectively solved with one method than with the other.

Problem Finding

Given that there are a large number of methods designed to enhance problem solving, it is surprising to find that there are very

few methods that are designed to enhance its first and potentially very important stage-problem finding. An extensive review of the creativity literature revealed the following three techniques.

The first method, proposed by Parnes (1967) in a creative training programme, suggests that problem finding may be enhanced by replacing the word "problem" with the word "challenge" or "opportunity". Using the word problem and challenge interchangeably, Parnes writes "Sometimes it's hard to realize all the challenges we face because we are used to thinking of challenges as conflicts and we tend to blind ourselves to some of our problems in order to feel more comfortable" (p.120).

Parnes (1967) also suggests, that problem finding may be enhanced by using checklists. These may contain lists of questions that relate to work or personal life. However, this method tends to be very restrictive as checklists are often comprised of a limited number of items (Stein,1974a).

Finally, Adams (1987) suggests that problem finding can be enhanced by making a list of those things that bug you.

As yet, no research to evaluate these problem finding methods has been undertaken. Therefore, their effectiveness remains unknown.

Problem Solving and Problem Finding within Organizations

In an attempt to increase profits and competitiveness, a large number of organizations have implemented systems to enhance the creative process. These systems include suggestion schemes, quality circles and job rotation.

Suggestion Schemes

The suggestion scheme is designed to encourage employees to solve work related problems, especially those that will save money. As an incentive, employees are typically paid 10-20 percent of the savings made in the first year (Greenlaw & Biggs,1979).

Suggestion systems have been adopted by a wide range of industries, however, the number of suggestions submitted by employees tends to be low. For example, in 1966 the Swedish mechanical industry received an average of only 5.1 suggestions per 100 workers (Ekvall,1971).

A possible reason for the low suggestion rate is that employees must first be able to identify a problem and then also be able to solve that problem

However, Ekvall (1971) noted that employees may fail to identify even the most obvious problems because they adjust to them. Even when employees do identify problems, without the necessary problem solving skills they may still fail to resolve them.

Quality Circles

A system that provides employees with methods to enhance both problem solving and problem finding is quality circles (QCs). These are comprised of small groups of volunteers that meet regularly from the same work areas to identify, analyse and solve work related problems.

Circle members are trained in the use of brainstorming to enhance problem solving and are also provided with checklists to enhance problem finding.

Even though quality circle members are provided with methods to enhance both problem solving and problem finding the number of

problems solved by these groups tends to be low.

A 1976 survey of 360 Japanese companies found that 70 percent of quality circles solved only 1 or 2 problems over a one year period (Ishikawa,1985).

Also Griffin (1988) found that the beneficial effects of the quality circles tend to disappear with the passage of time.

A possible reason for the poor performance of quality circles has been proposed by Ferris & Wagner (1985). They wrote "As a whole, American research appears to suggest that intellectual, novel, brainstorming-type tasks, such as the tasks often undertaken by QCs, can be better performed by individuals than by groups" (p.157).

Job Rotation

Roman (1968) suggests that creativity may be enhanced by job rotation. He wrote "The exposure to new people, the change of immediate environment, and the crossbreeding of ideas inspire added insight" (p.291).

McKenna (1989) also noted that if the same members of a development team work together, then over time the team tends to lose its ability to innovate.

Therefore, it would seem that creativity may be enhanced by job rotation and inhibited by extended experience.

Creativity and Experience

Underlying approaches to enhance creativity is the assumption that past experience in a given field can inhibit creativity while exposure to new environments can enhance it. Sternberg (1989) wrote "often the most creative work in a given area is done by people who are relatively new to the field and who know a fair amount about that field, but not too much about it" (p.138).

The literature on creativity and innovation is sprinkled with examples and observations that seem to support this assumption. A study of invention and inventors by Jewkes, Sawers & Stillerman (1969) identified numerous examples of outsiders succeeding to innovate where experts had failed. For example Gillette, who invented the safety razor was a traveling salesman and Dunlop, an inventor of the pneumatic tyre, was a veterinary surgeon. Jewkes also found that scientists and technologists, specialized in one field, inventing in fields relatively unknown to them. In the field of scientific revolutions, Kuhn (1970) noted that it is almost always those that are either very young or new to a field that are able to bring about fundamental changes in a paradigm. Also creative people in general have been found to have experienced a wide variety of new environments.

As yet, it is not fully understood why exposure to new environments should enhance creativity. Jewkes, Sawers & Stillerman suggests that it is because "Long practice in a profession tends to form a crust on the mind (not, of course, without its value for many purposes) which results in things being taken for granted, in assumptions becoming deeply embedded, in simple questions being asked the most rarely" (p.98). Sternberg (1989) also notes that "One can become so entrenched in set ways of seeing issues and problems that one is unable to go beyond the existing paradigms and points of view" (p.137-138).

In an attempt to understand how new environments enhance creativity a review of the research relating to the "problem solving" and the "problem finding" stages of the creative process is undertaken.

Problem Solving

Early problem solving research sought to show that past experience can inhibit productive thinking.

In one experiment Duncker (1945) presented subjects with a candle, a box of tacks and a box of matches and asked the subjects to attach the candle to the door. Duncker found that subjects very rarely used the empty tack box as a support for the candle. It was hypothesized that because the tack box is usually used as a container it interferes with its other possible use as a support for the candle. However, research on the candle problem by Weisberg & Suls (1973) suggests that rather than past experience inhibiting problem solving that past experience can actually facilitate problem solving. Weisberg & Suls asked subjects solving the candle problem to think aloud. It was found that subjects would first attempt a solution based on the criteria given and if the solution was in some way inadequate then attempts would be made to correct the inadequacy until the problem was solved. Solving the candle problem was therefore found to be based directly on the knowledge of the problem solver.

Scheerer (1963) identified a similar type of problem that was also thought to be difficult to solve because of past experience. The problem requires subjects to draw four lines through the nine dots arranged as a square without lifting the pencil off the paper. The only way for subjects to solve the nine dot problem is to draw the lines outside the boundaries of the square. Scheerer suggests that the reason most subjects fail to solve the nine dot problem is that subjects incorrectly assume that the lines must be drawn within the boundaries of the square. To ensure that subjects didn't make this assumption Weisberg & Alba (1981) told subjects that the solution

involves drawing lines outside the boundaries of the square. They found that even though subjects used this information that they were still unable to solve the problem. Weisberg & Alba were, however, able to facilitate the solving of the nine dot problem by providing subjects with experience in solving similar types of problems.

These findings suggest that experience and knowledge are essential for effective problem solving. Problem solving research in areas such as physics, mathematics, and chess has also found that detailed knowledge or expertise is essential for effective problem solving.

It seems that the development of this problem solving expertise requires extensive study and training. In a classic study of chess masters, de Groot (1965,1966) found that masters had an exceptional ability to recall the positions of chess positions, a skill that Weisberg (1986) calculated would require at least ten years of intensive practice and study to attain. Hayes (1989) also found that it was only after ten years of intensive music experience that great composers started to produce masterworks. After this period the output dramatically increased, therefore suggesting that at least 10 years of intensive music training is necessary before great composers can begin to produce masterworks.

Effective problem solving therefore seems to depend on extensive domain-specific knowledge acquired after long periods of training and practice. Greeno (1980) notes that it is therefore "not an accident that most of the creative achievements that we recognize are accomplished by individuals who have spent many years working on problems in the fields in which they make their contributions" (p.21).

Therefore, it would appear that novices, without the necessary knowledge and training, would be unlikely to achieve creative breakthroughs, let alone have an advantage over experts. Greeno summarized this point when he wrote "There will undoubtedly continue to be exceptional novices who miraculously achieve

insights that have been missed by all the experts in the establishment. However, I think there is no basis in current scientific knowledge for changing our present policy of intensive disciplined training for individuals who aspire to making creative changes in the domains in which they choose to work" (p.21).

Problem Finding

The first and potentially most important stage of the creative process is problem finding. Einstein & Infield (1938) wrote "The formulation of a problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skill. To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance in science" (p.95).

Darwin thought that the most difficult part was finding the right problems to solve. Edison was found to be not good at problem solving as one might expect, but good at problem finding. Wertheimer (1945) commented "Often in great discoveries the most important thing is that a certain question is found" (p.123).

Given the importance of problem finding in creativity, it is surprising to find that very little research has been done in this area. An understanding of the problem finding process promises to increase our understanding of the creative process.

Dillon (1988) defines problem finding as "a process which eventuates in a problem to solve" (p.105). Although very little is understood about the problem finding process, a conceptual scheme has been proposed by Dillon (1982).

Dillon (1982) hypothesized that problem finding may involve three existential levels of problems with three corresponding psychological activities.

At the first level, a problem is defined as existing. The problem is evident and only requires recognition.

At the second level, an emergent problem exists which is hidden rather than obvious. Here the problem finder discovers the problem.

At the third level, a potential problem exists. No actual problem itself exists. The problem finder actually invents the problem.

These three problem levels correspond closely to what Getzels (1982) termed: presented, discovered, created problem situations.

However, there is a slight difference between a presented problem and an evident problem. A presented problem is given and therefore requires little or no problem finding. An evident problem is not given and is therefore thought to be one step removed from the presented problem.

Unfortunately Getzels (1975,1988) combined " discovered and created problem situations" into the one category of discovered problem situations.

This approach tends to overlook the important differences that are likely to occur between problem discovery and problem invention.

Dillon suggests that the activity required to discover hidden problems and to create new problems is likely to represent a more sophisticated, distinct and difficult activity than finding an evident or obvious problem.

Getzels (1964,1982) also suggests that problems that range from presented problem situations to discovered problem situations involve increasing levels of creativity and innovation for their solution.

Problem finding research has therefore tended to focus on the study of implicit and potential problems. Probably the most influential in this field is the study of potential problems by Getzels & Csikszentmihalyi (1976).

Working with fine-art students, Getzels & Csikszentmihalyi devised a way of observing and quantifying the problem finding behaviour of artists. In their experimental design, 31 fine-art students were required to select from among 27 still-life objects and to arrange them in such a way as to compose a still-life drawing. The pictures drawn by the art students were judged by five art critics on originality and overall artistic value.

Those subjects that handled more of the objects, explored the objects more closely, selected more of the unusual objects and produced pictures that were rated as being more original and having a higher overall artistic value.

The art students were also interviewed about their concern for discovery. Those students without a predetermined problem in mind were rated higher on originality. Therefore it was concluded that the artists that produced the less original works used a predetermined pattern whereas the more original artists with no such predetermined pattern were open to more possibilities and therefore handled and explored more of the objects.

This approach may be generalized to other potential problem situations. Moore (1985) successfully used this approach with student writers and found similar results. The writers that were judged to be more creative selected more of the objects, more unique objects and they touched more of the objects prior to writing.

Arlin (1976) used this approach in an attempt to gain a better understanding of problem finding behaviour.

Sixty college seniors were presented with 12 common objects and asked to raise questions about them. Based on Mackworth's (1965) assumption that effective problem finding involves the identification of general questions, Arlin sought those students that identified general questions.

To achieve this, Arlin applied the intellectual product categories of Guilford's (1956) structure of the intellect model. This model consists of the following six categories: units, classes, and relations and the three more complex categories: systems, transformations and implications.

Arlin found that those students who asked only a few questions would tend to ask them from the more complex categories. Whereas those students who asked more questions would tend to ask them from less complex categories.

Unfortunately, Arlin did not quantify the student's problem finding behaviour by recording the number of the objects selected, the uniqueness of the objects selected, and how closely they were examined. Therefore, it is impossible to validate both Mackworth's assumption that effective problem finding is the finding of general questions and Arlin's conclusion that successful problem finders generate a few general questions rather than a large number of less general questions.

Getzel's method of observing and quantifying the problem finding behaviour of potential problems was applied by Moore (1987a,1990) to the study of implicit problems. Moore attempted to investigate the differences in problem finding behaviour between student and experienced teachers in a simulated classroom setting.

Teachers were asked to pretend that they would be replacing a teacher in a simulated classroom and to identify problems that a replacement teacher would face. It would seem that making measurements that include counting the number of objects inspected and the uniqueness of the objects examined would not be well suited

to a situation where problem information is likely to be embedded within printed material on the teachers desk. For example, Moore noted that items such as a poster and a drinking cup would appear to have little value in identifying problems but would raise a subjects uniqueness score if handled.

However, studies of enquiry behaviour by Shulman (1965) and Allender (1969) provide a potentially useful approach to quantify and observe the finding of implicit problems.

Shulman (1965) studying teacher enquiry behaviour developed an "In Basket" technique to measure teacher's sensitivity to problems. As with Moore's study, subjects were asked to sit at a simulated teachers desk and to search through teaching material relating to the newly assigned class. Within the material were embedded problems that ranged from the obvious to the very obscure. Subjects were encouraged to think aloud so that their enquiry approach could be determined. The subject's problem sensitivity score could therefore be calculated by counting the number of hidden problems that the subject reacted to in the
inquiry situation.

Allender (1969) used a similar approach to study inquiry activity in elementary school children. Subjects were asked to act out the roll of a mayor of a small city. Subjects were provided with the materials that a mayor would typically have to attend to. Each page was numbered at several points and if subjects perceived a problem they were required to request more information by simply quoting that number. Problem sensitivity was then calculated by counting the number of question pages requested.

Problem Finding and Experience

Problems are often encountered by novices when learning a new skill or when coping with a new environment. As yet very little is understood about the problem finding behaviour of novices and how it differs from experts.

A study of novice and experienced teachers by Moore (1987b,1990) does however, provide some understanding of these differences. Using a method similar to Shulman's (1965) Problem Sensitivity Study. Moore asked 30 experienced and student teachers to identify problems in a simulated classroom situation. Teachers were asked to pretend that they would be replacing a simulated classroom's teacher and to identify problems that a replacement teacher would face. Once they had completed the task, teachers were interviewed by the principal and the total number of problems raised per teacher was simply a count of the problems raised in the interview.

Moore found that student teachers identified significantly more problems than experienced teachers. Moore hypothesized that although student teachers would identify more problems than experienced teachers the experienced teachers would raise more general questions or what Werteimer (1945) calls "productive questions" than the student teachers would.

Moore utilized Arlin's definition of general questions which is based on Guilford's (1956) product categories. Student teachers were indeed found to identify fewer general questions than experienced teachers.Underlying Moore's definition of the productive or general question is the assumption that the problem finding activity is the same for all teachers. However, as with art students in the Getzels & Csikszentimihalyi (1976) study, students tended to approach a problem discovery situation in different ways. Some students approached the problem situation in terms of a discovered problem situation while others were thought to approach it in terms of a presented problem situation. Also Dillon (1982) suggests that some people may be better at one problem finding level than

another. So, for example, some people may be good at discovering implicit problems while others may be good at recognizing evident problems.

The case histories of innovators suggests to the author that novices or outsiders new to an environment, may be better able to discover implicit problems than those with experience in that field. For example, Arthur Jones, who invented the Nautilus exercise machine as described by Nayak & Ketteringham (1986), first realized that there was something wrong with the traditional way of weight lifting when he was only a teenager. He had found that training with the barbel helped him develop certain muscles but not others. Suspecting that there was something wrong with the barbel, Jones questioned the experts as to the cause of the problem. However, he found that the experts "had come to accept the inconsistency of muscle development as a fact of life, an unalterable condition of human travail" (p.266). Although it took Jones over thirty years for him to solve the problem, the result was an exercise machine that revolutionized the way weight lifting was done.

In another study by Nayak & Ketteringham they described the development of the magnetron which was invented by the British for use in radar. Two outsiders, initially an American and then later a Japanese were responsible for the major breakthroughs that led to its use in microwave ovens. On seeing the magnetron for the first time, both the American and the Japanese quickly discovered problems that initiated innovative development. The problems that they discovered had not been perceived by others as problems but as features.

If it can be shown that novices are better able to discover implicit problems than those with experience in that area then it would provide a way of enhancing creativity by enhancing problem finding.

Hypotheses

The foregoing analysis leads to three research hypotheses which are addressed in the remainder of this thesis.

[1] Novices identify more problems than those with experience.

[2] Novices identify more hidden problems than those with experience.

[3] Novices identify more novel problems than those with experience.

METHOD

Subjects

45 bank Tellers from a major banking corporation volunteered to participate in a study to record work related problems. Of these, there were 32 females and 13 males.

Bank Tellers were targeted specifically because the work they perform is the same regardless of their work experience. The Tellers participating comprised three levels of work experience, 15 novice Tellers with up to 6 weeks work experience, 15 intermediate Tellers from 6 weeks to 1 years work experience and 15 experienced Tellers with over 1 years work experience.

Tellers volunteered to participate after the memorandum (see appendix), which outlines the basic procedure of the study, was circulated to branch managers. This resulted in 5 novice, 7 intermediate and 11 experienced Tellers volunteering to participate in the study. A further 5 intermediate and 4 experienced Tellers volunteered to participate when the initial volunteers were given the survey forms.

As there were still an insufficient number of subjects, Tellers were approached during staff training and given an outline of the basic procedure of the study. This resulted in a following 10 novice and 3 intermediate Tellers volunteering to participate.

Measures

Survey Form

The survey form (see appendix) provided an opportunity for Tellers to list work related problems.

The survey form requires that Tellers record as many questions and difficulties as possible concerning: [1] Customer contact, [2] Use of the terminal and [3] Any other work related procedures.

The form emphasizes the importance of listing problems regardless of how small and insignificant, or large and complex that they might be. This was to ensure that all problems were listed, not only those that were perceived to be important enough to record.

It should be noted that throughout the study the word problems has been used interchangeably with the word difficulties, as the word difficulties was thought by management to contain fewer negative connotations.

Participation in the survey was voluntary and names were not recorded to ensure that Tellers were not inhibited in their recording of problems.

The Number of Problems

The number of problems was calculated by summing each problem recorded in the survey form.

The Number of Hidden Problems

The number of hidden problems was determined by asking two independent members of management to rate all problems identified by Tellers as either hidden or obvious. Their instructions were: If you were a teller do you think this would be an obvious (easy to see) problem or would it be rather hidden and obscure? Write O next to those problems that are obvious(easy to see) and H next to those problems that are rather hidden and obscure.

The number of hidden problems was calculated by summing each problem that management rated as being hidden.

The Number of Novel Problems

The number of novel problems was determined by asking two independent members of management to rate all problems identified by Tellers as either aware or unaware of. Their instructions were: From the following list of problems please indicate which problems you are aware, and which problems you are unaware of. Write A next to those problems you are aware of and U next to those problems that you are unaware of.

Throughout the study, novel problems were defined as those problems that management were unaware of.

The number of novel problems was calculated by summing each problem that management rated as being unaware of.

Procedure

The Tellers that volunteered to participate in the study were approached by the author and were given the survey form at the beginning of the working day.

To ensure that all Tellers received the same information, the author read out the instruction sheet of the survey form. This requires Tellers to list work related difficulties for that working day.

The survey forms were collected by the author at the end of the day. The Tellers were asked for their length of work experience, and this information and their sex, was recorded on their survey form.

All problems recorded by Tellers were then given to two members of management with extensive Teller experience. They were instructed to independently rate which of the problems they perceived to be hidden, and which problems were obvious.

The problems recorded by Tellers were then presented to a further two members of management with extensive Teller experience. They were instructed to independently rate which of the problems they were aware, and unaware of.

All problems recorded by Tellers were then categorized by two members of management.

RESULTS

A one-way anova was conducted on the number of problems, the number of hidden problems and the number of novel problems that were identified by novice, intermediate and experienced Tellers.

For each analysis of the number of problems, the number of hidden problems and the number of novel problems, post hoc paired comparisons were made between novice, intermediate and experienced Tellers using the Fisher PLSD test.

Finally, a brief analysis of the problem categories was undertaken.

The Number of Problems

The one-way anova gave a significant result for the number of problems identified by novice, intermediate and experienced Tellers, $F(2,42)=5.30$, $p<.01$.

Novice Tellers identified significantly more problems ($X=12.80$, $SD=6.68$) than intermediate Tellers ($X=6.47$, $SD=4.29$), Fisher $PLSD=5.62$, $df=42$, $p<.01$. Novice Tellers also identified significantly more problems than experienced Tellers ($X=7.53$, $SD=5.89$), Fisher $PLSD= 4.24$, $df=42$, $p<.05$. There was no significant difference between the number of problems that were identified by intermediate and experienced Tellers, Fisher $PLSD=4.21$, $df=42$, ns [see figure 1].

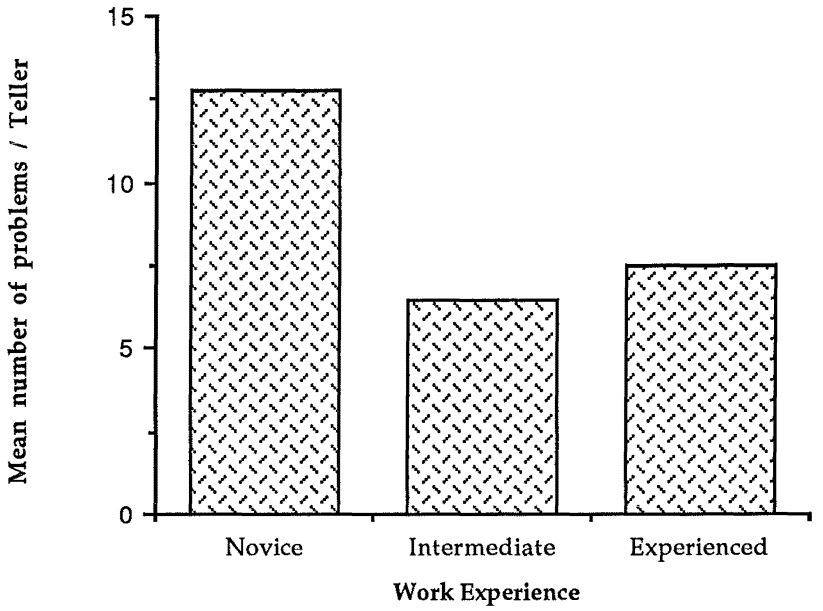

Figure 1. Comparison of the level of work experience and the number of problems / Teller.

The Number of Hidden Problems

The number of hidden problems that were identified by novice, intermediate and experienced Tellers as independently rated by two members of management is as follows:

Manager A

The one-way anova gave a significant result for the number of hidden problems identified by novice, intermediate and experienced Tellers, $F(2,42)=7.97$, $p<.01$.

Novice Tellers identified significantly more hidden problems ($X=5.2$, $SD=3.41$) than intermediate Tellers ($X=1.33$, $SD=1.45$), Fisher $PLSD=2.76$, $df=42$, $p<.01$. Novice Tellers also identified significantly more hidden problems than experienced Tellers ($X=2.13$, $SD=3.14$), Fisher $PLSD=2.76$, $df=42$, $p<.01$. There was no significant difference between the number of hidden problems that were identified by intermediate and experienced Tellers, Fisher $PLSD=2.06$, $df=42$, ns [see figure 2].

Manager B

The one-way anova gave a significant result for the number of hidden problems identified by novice, intermediate and experienced Tellers, $F(2,42)=7.25$, $p<.01$.

Novice Tellers identified significantly more hidden problems ($X=4.47$, $SD=2.13$) than intermediate Tellers ($X=1.40$, $SD=1.35$), Fisher $PLSD=2.23$, $df=42$, $p<.01$. Novice Tellers also identified significantly more hidden problems than experienced Tellers ($X=2.33$, $SD=2.99$), Fisher $PLSD=1.67$, $df=42$, $p<.05$. There was no significant difference between the number of hidden problems that were identified by intermediate and experienced Tellers, Fisher $PLSD=1.67$, $df=42$, ns [see figure 3].

In both ratings by management, novice Tellers identified significantly more hidden problems than intermediate and experienced Tellers. There was no significant difference between the number of hidden problems that were identified by intermediate and experienced Tellers.

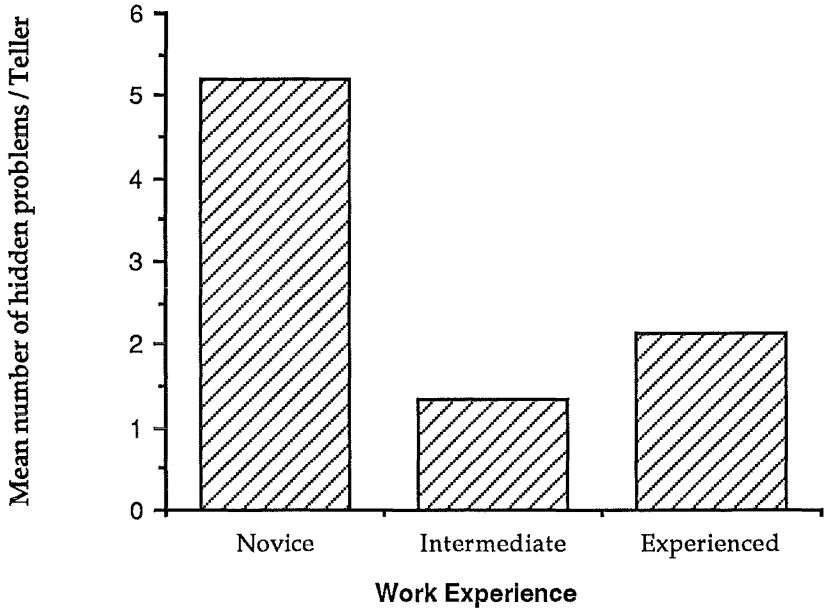

Figure 2. Comparison of the level of work experience and the mean number of hidden problems / Teller (Manager A).

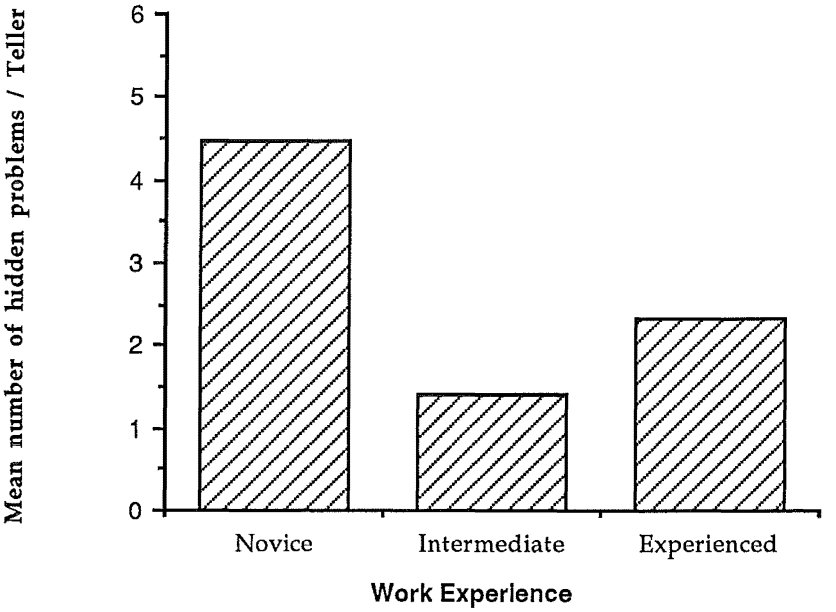

Figure 3. Comparison of the level of work experience and the mean number of hidden problems / Teller (Manager B).

The Number of Novel Problems

The number of novel problems that were identified by novice, intermediate and experienced Tellers as independently rated by two members of management is as follows:

Manager A

The one-way anova gave a significant result for the number of novel problems identified by novice, intermediate and experienced Tellers, $F(2,42)=11.98$, $p<.01$.

Novice Tellers identified significantly more novel problems ($X=5.67$, $SD=2.69$) than intermediate Tellers ($X=2.13$, $SD=1.81$), Fisher $PLSD=2.32$, $df=42$, $p<.01$. Novice Tellers also identified significantly more novel problems than experienced Tellers ($X=1.93$, $SD=2.46$), Fisher $PLSD=2.32$, $df=42$, $p<.01$. There was no significant difference between the number of novel problems that were identified by intermediate and experienced Tellers, Fisher $PLSD=1.73$, $df=42$, ns [see figure 4].

Manager B

As only a small number of novel problems were identified by Tellers, two non parametric tests, the Kruskal-Wallis and the Mann-Whitney U, were used to analyze the data.

The Kruskal- Wallis test was conducted on the number of novel problems that were identified by novice,intermediate and experienced Tellers.

Comparisons between pairs of groups were made using the Mann-Whitney U test.

The Kruskal - Wallis test gave a significant result for the number of novel problems identified by novice, intermediate and experienced Tellers, $H=6.31$, $df=2$, $p<.05$.

Novice Tellers identified significantly more novel problems ($X=1.0$) than intermediate Tellers ($X=0.4$), Mann-Whitney U, $Z=-1.97$, $p<.05$. Novice Tellers also identified significantly more novel problems than experienced Tellers ($X=0.3$), Mann-Whitney U, $Z=-2.281$, $p<.05$. There was no significant difference between the number of novel problems that were identified by intermediate and experienced Tellers, Mann-Whitney U, $Z=-.539$, ns [see figure 5].

In both ratings by management, novice Tellers identified significantly more novel problems than intermediate and experienced Tellers. There was no significant difference between the number of novel problems that were identified by intermediate and experienced Tellers.

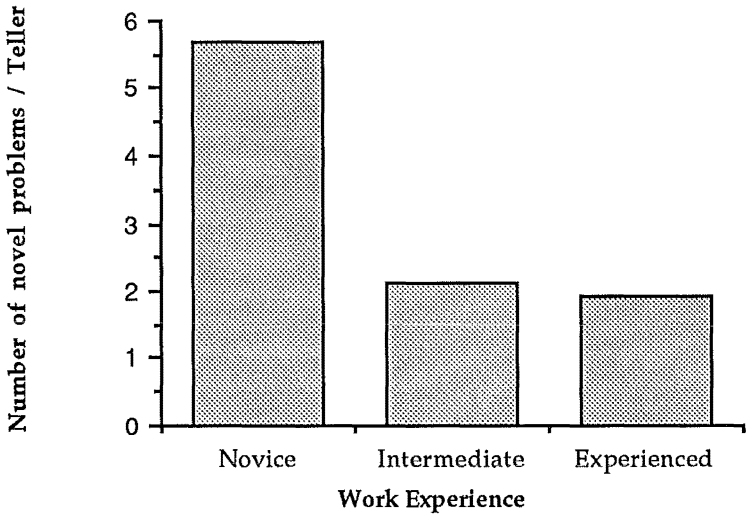

Figure 4. Comparison of the level of work experience and the mean number of novel problems / Teller (Manager A).

Figure 5. Comparison of the level of work experience and the mean number of novel problems / Teller (Manager B).

Problem Categories

All problems recorded by Tellers were categorized into five work related areas. These were: [1] Customer; [2] Staff; [3] Procedure & Maintenance; [4] Cash & Cheque; [5] Computer.

The Number of Problems

Chi-square tests were conducted on the frequency of problems occurring within each problem category [see table 1].

The Chi-square test gave a significant result for categories 2-5. These were: [1] Customer $\chi^2=3.22$, df=2, ns; [2] Staff $\chi^2=25$, df=2, $p<.01$; [3] Procedure & Maintenance $\chi^2=16.08$, df=2, $p< .01$; [4] Cash & Cheque $\chi^2=13.68$, df=2, $p< .01$; [5] Computer $\chi^2=7.09$, df=2, $p<.05$.

It is clear from inspection of table 1 that these differences are due to novices identifying more problems than subjects in either the intermediate or experienced groups.

The Number of Hidden and Novel Problems

As the frequencies for the number of hidden problems and the number of novel problems in each problem category was low the Chi Square test was unable to be used. However, it is clear from inspection of tables 2-5 that novices identified more problems than subjects in either intermediate or experienced groups.

Table 1. The number of problems identified by novice, intermediate and experienced Tellers in each problem category.

Problem category	Work Experience		
	Novice	Intermediate	Experienced
Customer	42	31	28
Staff	39	14	9
Procedure & Maintenance	42	15	20
Cash & Cheque	26	7	11
Computer	49	26	37

Table 2. The number of hidden problems identified by novice, intermediate and experienced Tellers in each problem category (Manager A).

Problem category	Work Experience		
	Novice	Intermediate	Experienced
Customer	27	13	11
Staff	12	1	3
Procedure & Maintenance	20	1	8
Cash & Cheque	12	2	2
Computer	9	3	7

Table 3. The number of hidden problems identified by novice, intermediate and experienced Tellers in each problem category (Manager B).

Problem category	Work Experience		
	Novice	Intermediate	Experienced
Customer	16	11	8
Staff	12	3	6
Procedure & Maintenance	16	5	5
Cash & Cheque	11	0	2
Computer	13	2	11

Table 4. The number of novel problems identified by novice, intermediate and experienced Tellers in each problem category (Manager A).

Problem category	Work Experience		
	Novice	Intermediate	Experienced
Customer	12	9	6
Staff	17	5	3
Procedure & Maintenance	22	8	6
Cash & Cheque	13	0	2
Computer	12	4	1

Table 5. The number of novel problems identified by novice, intermediate and experienced Tellers in each problem category (Manager B).

Problem category	Work Experience		
	Novice	Intermediate	Experienced
Customer	0	1	1
Staff	7	2	2
Procedure & Maintenance	7	3	1
Cash & Cheque	0	0	0
Computer	1	1	0

DISCUSSION

In the following discussion the author will review the results relating to the three hypotheses proposed in the introduction. An approach to enhance problem finding and problem solving will be presented and comparisons will be made with other problem finding and problem solving techniques.
Finally, directions for future research will be outlined and conclusions drawn.

The present study found that novice Tellers identified significantly more problems than intermediate and experienced Tellers. Therefore, confirming the hypothesis that novices identify more problems than those with experience.

This finding has also been confirmed by Moore(1987b,1990) in a study of school teachers. Novice teachers identified significantly more problems than experienced teachers.

However, an unexpected finding was that experienced Tellers identified more problems than intermediate Tellers. The assumption in the study that Tellers all perform the same work regardless of their work experience was was found to be incorrect. Novice and intermediate Tellers worked continuously as Tellers, but experienced Tellers were rotated to different jobs every 6 weeks. This suggests that the increase in the number of problems identified by these experienced Tellers resulted from their exposure to new environments.

An analysis of the number of hidden problems found that novice Tellers identified significantly more hidden problems than intermediate and experienced Tellers. Therefore, confirming the

hypothesis that novices identify more hidden problems than those with experience.

The increase in the number of hidden problems that were identified by experienced Tellers in comparison with intermediate Tellers suggests that the increase resulted from the job rotation.

The conceptual scheme proposed by Dillon (1982), specifies "problem discovery " as the activity involved in identifying hidden problems. Therefore, novices are better at problem discovery than those with experience.

Implicit in the notion of problem discovery is the idea that problems discovered are novel. In the present study novice Tellers identified significantly more novel problems than intermediate and experienced Tellers. Therefore, confirming the hypothesis that novices identify more novel problems than those with experience.

The findings from the three hypotheses confirm that novices are able to identify more problems, more hidden problems and more novel problems than those with experience.

Further, analysis of the problem categories showed that in each category novices identified more problems, more hidden problems, and more novel problems than did those with experience.

These findings suggest that novices are therefore better problem finders than those with experience.

Jewkes, Sawers & Stillerman (1969); Sternberg(1989) and others have suggested that exposure to new environments enhances creativity. Jewkes, Sawers & Stillerman suggested that it is because "Long practice in a profession tends to form a crust on the mind (not, of course, without its value for many purposes) which results in things being taken for granted, in assumptions becoming deeply embedded, in simple questions being asked the most rarely" (p.98). Also Sternberg (1989) suggested that this occurs because

"One can become so entrenched in set ways of seeing issues and problems that one is unable to go beyond the existing paradigms and points of view" (p.137-138).

However, the finding that novices are better problem finders than those with experience suggests that the reason exposure to new environments enhances creativity is that exposure to new environments enhances problem finding and therefore enhances creativity.

The Enhancement of Problem Finding

Problem finding can be enhanced by novices identifying problems rather than those with experience.

This technique differs from other problem finding techniques. For example, Adams (1987) suggests that problem finding can be enhanced by making a list of things that bug you. The author suggests that a more effective technique would be to enter new environments and make lists of the things that bug you. Adams also suggests that problems may be identified by interviewing people about their needs. The author's proposed method to enhance problem finding would involve interviewing only those that are new to an environment.

The Enhancement of Problem solving

Given that problem finding is potentially the most important stage in the creative process, it would seem reasonable to assume that novices, who are better problem finders than those with experience, would be responsible for the majority of the creative breakthroughs. However, most creative works are achieved by those with extensive experience (Greeno, 1980).

Research in problem solving has found that effective problem solving requires extensive domain specific knowledge, knowledge that novices are unlikely to possess. Therefore, although novices are better problem finders than those with experience, they are unlikely to be able to translate these problems into creative ideas.

Therefore, the author suggests that problem solving can be enhanced by those with experience solving the problems identified by novices.

The proposed approach differs from suggestion schemes. Suggestion schemes rely on employees both to identify problems and to solve them. The findings from the present study suggest that novices have the potential to contribute to suggestion schemes as they are better problem finders than those with experience but that their lack of experience would prevent them from making suggestions as they would not have the experience to solve problems identified. Therefore, the proposed technique to enhance problem solving would provide an important addition to suggestion schemes.

A system that involves small groups of employees identifying and solving work related problems is called quality circles. The author suggests that
quality circles should include novice employees which would then enhance the number of problems found.

A technique that is thought to enhance creativity is job rotation. The results of the present study suggest that job rotation enhances problem finding but not problem solving. Therefore, the proposed technique to enhance problem solving would provide an important addition to job rotation.

Directions For Future Research

[1] A limitation of the present study was that factors such as age, sex and level of motivation were unable to be controlled. The author would therefore suggest that future research might involve a laboratory study in which subjects of varying background are presented with familiar and unfamiliar equipment and instructed to identify problems with its use.

[2] As the present study involved novices new to an organization the author therefore suggests that future research might focus on employees who are experienced within an organization and who are transferred from one section of the organization to another.

[3] Future research might focus on just novices to determine at what point after entering a new environment they are able to identify the optimum number of problems.

[4] A longitudinal study could be undertaken within an organization to assess the benefits accruing from the problems identified by novice staff and the problems identified by experienced staff.

Conclusions

The results of the present study suggest that novices are better problem finders than those with experience.

This suggests further that the reason exposure to new environments enhances creativity is that it enhances problem finding.

In the author's opinion, problem finding can be enhanced by novices identifying problems rather than those with experience.

Although novices are better problem finders, those with experience are better problem solvers.

Therefore, it is likely that problem solving can be enhanced by those with experience solving problems identified by those that are new to an environment.

The proposed methods for enhancing problem finding and problem solving are, in the authors view, an important innovation that have the potential to enhance creativity.

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Appendix

MEMO TO:

BRANCH: S. Feldbrugge

FROM: Senior Training Manager

DATE: 28 November 1989

SUBJECT: RESEARCH PROJECT:

Our Bank has been approached by the University of Canterbury in regard to assisting Mr Conrad Heraud who is a Masters student, carry out research for his thesis.

He would like to study some of the problems experienced by Tellers within Trust Bank.

All participation in the project is voluntary and names will not be recorded. The survey will be to record questions and difficulties experienced over a period of one working day.

Participation will be graded into 3 separate groups with 15 required in each group.

1. Tellers with less than 6 weeks work experience.
2. Tellers with 6 weeks to 1 year's experience.
3. Tellers with over 1 year's work experience.

If any of your staff would like to participate please forward their names to me by 8 December stating their category. Further information and a talk with the Manager and staff concerned, will be arranged once participants have been finalized.

S. Feldbrugge.

SURVEY FORM

A research project by

Conrad Heraud
of the
University of Canterbury
Psychology Department

Until now, little research has identified the difficulties employees encounter during their work. This questionnaire seeks to establish the sort of questions they might ask themselves about these difficulties. This research attempts define issues that can be addressed to increase your job satisfaction.

Participation in this survey is entirely voluntary. Please do not write your name on this form as it is intended that the information received shall be anonymous.

If you feel that you would like to participate (and can find the time today) then please list difficulties you encounter during the day, or have encountered recently, and any questions you have asked yourself about difficulties concerning:

> [1] Customer contact (including customer enquiries and communication). Questions and difficulties relating to receiving and paying out cash and cheques to customers should also be included.
>
> [2] Use of the Terminal (including password and Cash Flow procedures). Questions and difficulties relating to the clearing of checks and the balancing of accounts should also be included.
>
> [3] Other work related procedures which are not covered in the above two categories.

Try to record as many questions and difficulties as you can, regardless how small and insignificant, or large and complex as these might be. Please do this yourself without comparing your comments with others. This is just for today. I will collect this form from you once you have finished work for today.

Thank you for your participation.

[1] List difficulties you encounter, or have recently encountered, and questions you ask yourself or have recently asked yourself about difficulties encountered with customer contact (including customer enquiries and communication). Questions and difficulties relating to receiving and paying out cash and cheques to customers should also be included.

[2] List difficulties you encounter, or have recently encountered, and questions you ask yourself or have recently asked yourself about difficulties related to use of the the Terminal (including password and Cash Flow procedures). Questions and difficulties relating to the clearing of cheques and the balancing of accounts should also be included.

[3] List other procedural questions and difficulties encountered during your work which were not covered in the preceding two pages.